FORAGING ACTIVITY OF MIGRATING BRANT AT STUBBS ISLAND IN APRIL 1989 FOLLOWING THE NESTUCCA OIL SPILL

Michael S. Rodway

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Abstract

Clayoquot Spit on the north end of Stubbs Island is a traditional staging and feeding area for Brant migrating north along the west coast of Vancouver Island. Oil from the Nestucca spill, which occurred off Washington on 23 December 1988, impacted Stubbs Island early in January 1989. To assess potential perturbation to migrating Brant in the spring of 1989, a study of Brant foraging behavior was conducted throughout the period they were present on the island.

Flocks of up to 480 birds were counted at Stubbs Island during the study period. Brant spent more time swimming offshore than foraging. Of the total time spent by all birds observed, Brant spent 48 percent swimming, 32 percent foraging, 10 percent flying, eight percent preening and two percent in other activities. Birds spent significantly more time foraging at low and medium tides than during high tides.

Disturbances, that put all Brant into flight, occurred during 31 percent of the observation intervals. Bald Eagles and Ospreys were responsible for 64 percent, and planes and boats passing close by accounted for 25 percent of those disturbances. The frequency of disturbance reduced the amount of time Brant spent foraging.

Small pockets of eelgrass in the northwest bay of Stubbs Island were still coated with oil, but no Brant foraged there. There was no indication during this study or from anecdotal reports by local observers that Brant normally used that area. No oil was detected in the main foraging area on the north end of the island, and there was no obvious perturbation to Brant behavior caused by the presence of oil.

Herring, which traditionally spawn in the vicinity of Stubbs Island, did not spawn there in 1989. Herring spawn appears to be an important food resource for migrating Brant in some areas, but it is unknown to what extent Brant stopping at Stubbs Island normally feed on spawn. Whether the presence of oil affected the distribution of herring spawn was beyond the scope of this study.

All Brant on Stubbs Island were inspected for leg bands and nasal disks. Three birds marked with nasal disks were sighted during the study. Those birds were marked in northern Alaska. No birds with leg bands were observed. Information on migration patterns will assist management of specific sub-populations.

Résumé

La pointe Clayoquot, à la section nord de l'île Stubbs est un site traditionnel de repos et d'alimentation pour la bernache cravant lors de sa migration printanière le long de la côte ouest de l'île de Vancouver. L'huile du déversement Nestucca, qui eut lieu au large de l'état de Washington le 23 décembre 1988, a contaminé l'île Stubbs en janvier 1989. Afin d'évaluer les effets possibles d'une telle perturbation sur la bernache cravant, le comportement alimentaire de la bernache cravant fut étudié sur l'île Stubbs au printemps 1989.

Des groupes contenant jusqu'à 480 oiseaux furent observés près de l'île Stubbs durant la période d'étude. Les bernaches cravant passèrent plus de temps à nager au large qu'à s'alimenter. Les bernaches cravants occupèrent 48% du temps total d'observation à nager, 32% à s'alimenter, 10% à voler, 8% à se nettoyer et 2% dans d'autres activités. Les Bernaches s'alimentèrent plus fréquemment aux marées basses et intermédiaires qu'aux marées hautes.

Des dérangements causant l'envol des bernaches cravant furent observés durant 31% des périodes d'observations. L'Aigle à tête blanche (Haliaeetus leucocephalus) et l'aigle pêcheur (Pandion haliaetus) causèrent 64% des envols tandis qu'avions et bateaux furent responsable de 25% de ces envols. Ces dérangements résultèrent en une diminution du temps d'alimentation des bernaches cravant.

Des poches de zoostères dans la baie nord-ouest de l'île Stubbs étaient encore recouvertes d'huile et aucune bernache ne s'alimenta à cet endroit. Les observateurs locaux indiquèrent que les bernaches cravant n'ont jamais utilisé ce site de par le passé. Aucune trace d'huile ne fut observée au principal site d'alimentation à l'extrémité nord de l'île, et le comportement de la bernache cravant n'a pas semblé affecté par la présence d'huile.

Le hareng, qui fraie traditionnellement à proximité de l'île Stubbs, n'a pas frayé là en 1989. Les oeufs d'harengs sont apparemment une source de nourriture importante pour les bernaches cravants à certains endroits, mais nous ne savons pas à quel point ils sont important pour les bernaches fréquentant l'île Stubbs. Les causes de l'absence de fraie du hareng à l'île Stubbs sont inconnues.

Toutes les bernaches cravants de l'île Stubbs furent observées afin de déterminer la présence d'oiseaux bagués ou avec disques nasaux. Trois oiseaux avec disques nasaux, marqués dans le nord de l'Alaska, furent observés durant l'étude. Aucun oiseau bagué ne fut observé. L'information sur les patrons de migration aidera à l'aménagement de sous-populations distinctes.

Table of Contents

	Page
Abstract	i
Resume	ii
List of Tables	iv
List of Figures	iv
List of Appendices	iv
Acknowledgements	v
Introduction	1
Methods	3
Results	5
Arrival of Brant	5
Activity patterns	5
Disturbance	12
Presence and affect of oil	13
Observations of marked birds	13
Discussion	14
Literature cited	16

List of Tables

Page

Table 1. Weather conditions during the study of Brant behavior on Stubbs Island, April 1989. 4

Table 2. Mean numbers of birds and mean daily activity of migrating Brant at Stubbs Island, April 1989 6

Table 3. Total Brant-hours spent in various activities by migrating Brant during observations at Stubbs Island, April 1989 . . . 6

Table 4. Mean activity during three phases of the tide (see Appendix II) of migrating Brant at Stubbs Island, April 1989 7

List of Figures

Figure 1. Location of study area and incidence of oil from the Nestucca spill on Stubbs Island. 2

Figure 2. Brant activity at Stubbs Island on 17 and 18 April 1989. . . 8

Figure 3. Brant activity at Stubbs Island on 22 and 25 April 1989. . . 9

Figure 4. Brant activity at Stubbs Island on 26 and 27 April 1989. . . 10

Figure 5. Brant foraging activity in relation to tide level at Stubbs Island, April 1989 11

List of Appendices

Appendix I. Activity of migrating Brant at Stubbs Island, April 1989. 18

Appendix II. Summary of Brant activity, disturbance and the phase of the tide on Stubbs Island, April 1989 23

Acknowledgements

This study was part of an ongoing evaluation of the impact of the Nestucca oil spill on the west coast of Vancouver Island. It was funded by Environmental Protection, Conservation and Protection, Environment Canada. R. McKelvey, Canadian Wildlife Service, was the scientific authority for the contract, and along with J-P. L. Savard, helped with the design of the study. J. Smith provided statistical advice and assistance. M. Lemon proof read a draft of this report, J-P.L. Savard translated the abstract into French, and S. Garnham prepared the manuscript for publication. Their help was greatly appreciated.

INTRODUCTION

Clayoquot Spit, on the north end of Stubbs Island, is a traditional staging and feeding area for Brant (Branta bernicla) in spring migration along the west coast of Vancouver Island (Fig. 1). Though there are extensive undisturbed eelgrass (Zostera marina) beds elsewhere in southern Clayoquot Sound, staging Brant are rarely sighted away from Stubbs Island (Hatler et al. 1978, Rodway 1989). The peak of migration now occurs during April (Campbell et al. 1989), though there used to be a substantial movement of Brant through the area in March (Hatler et al. 1978). Vagrant flocks have been sighted in the area in January and February (Rodway et al. 1989). Small numbers also occur in pelagic waters in Barkley Sound in March and April (Hatler et al. 1978, M. Lemon unpub., Rodway 1989).

Oil from the barge "Nestucca", spilled off Washington 23 December 1988, impacted Stubbs Island early in January 1989 (Environmental Protection database 9 March 1989). The largest quantities of oil came ashore on the west side of Stubbs Island in early January, but about 10% of the exposed eelgrass in the northwest bay was oiled, and patches of oil sheen were observed in the northeast bay on 1 February 1989. Subtidal oil was found by SCUBA divers in the channel south of Stubbs Island on 7 January (Rodway et al. 1989).

Brant depend on food resources along their migration route to develop body reserves for breeding (A. Reed pers. comm.). Disruption of normal foraging patterns could reduce their fitness for breeding. The objective of this study was to monitor Brant foraging behavior at Stubbs Island in the spring of 1989, and to assess possible perturbation to that behavior caused by the Nestucca oil spill. Studies were conducted throughout the period Brant were present on the island.

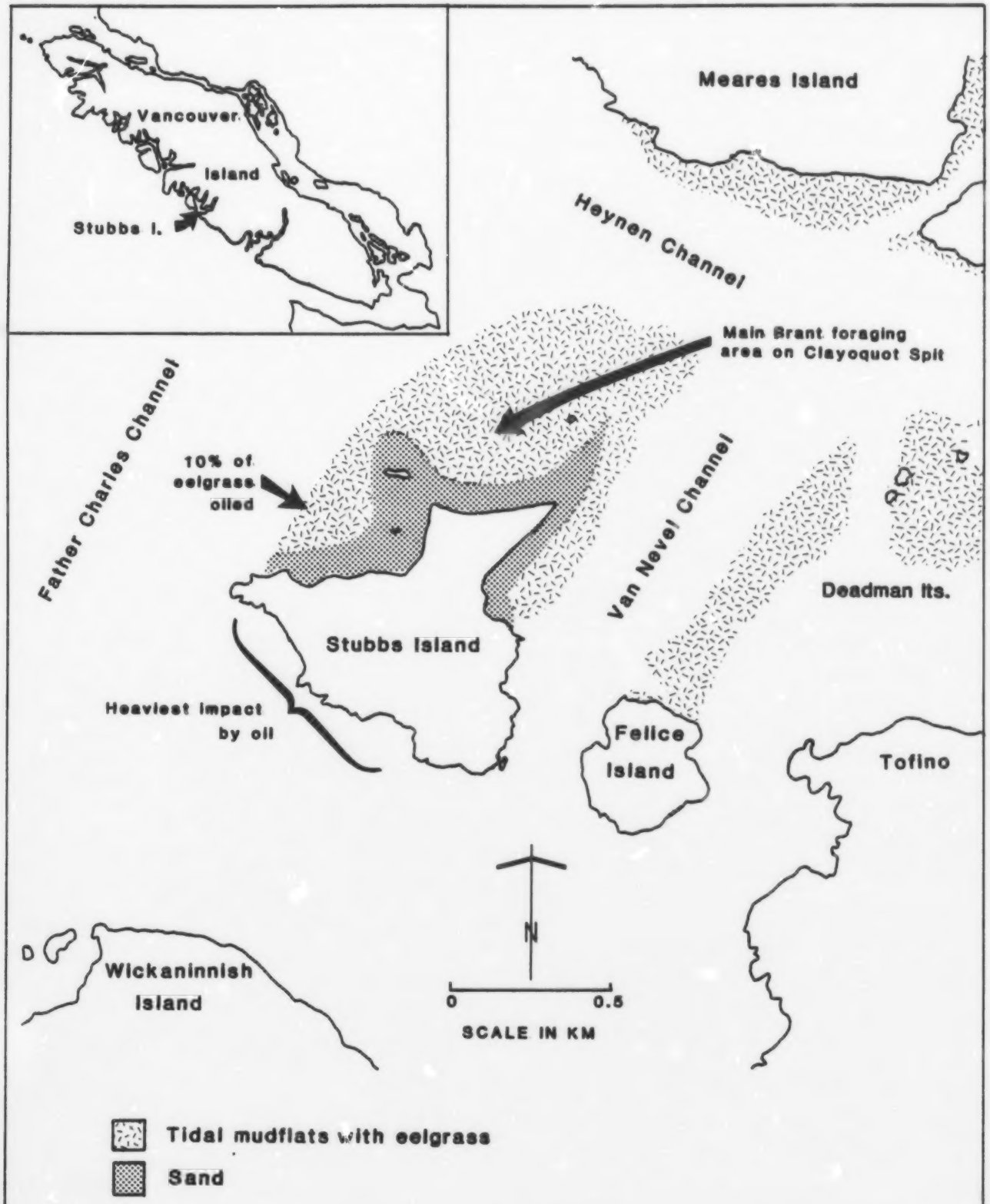


Figure 1. Location of study area and incidence of oil from the Nestucca spill on Stubbs Island.

Brant flocks were also scrutinized for marked birds, in cooperation with a survey being conducted on the east coast of Vancouver Island to determine migration routes of different sub-populations (Dawe and Nygren 1989). Information gathered from that survey will assist management of specific sub-populations, and help evaluate the significance of local disturbances.

METHODS

Stubbs Island was surveyed intermittently, beginning on 20 March, to monitor the arrival of Brant (see Rodway 1989). After they had arrived and began to forage, the study of activity patterns began. The study continued until all Brant had left the area. Observations were conducted on seven days between 17 and 28 April, for a total of 42.25 h, extending over all phases of the tidal cycle. No observations were made at night.

Instantaneous samples of behavior (Altmann 1974) were taken at 15 minute intervals throughout the observation periods, for a total of 176 samples. The entire flock was scanned with a 20X telescope, and the behavior of each bird was recorded as foraging, swimming, preening, flying, walking, standing, sleeping, or agonistic. Foraging behavior was categorized into "tipping up", "head dunking", surface pecking offshore, surface pecking at shore, grazing and probing. The first three behaviors always occurred in the water. Surface pecking at shore included all birds foraging at the water's edge, whether they were in the water or standing on shore. Grazing and probing occurred onshore on exposed eelgrass beds or mudflats. Grazing birds were feeding on exposed eelgass, while probing birds had their bills buried in the mud and appeared to be grubbing. Behavior was coded as swimming if a bird was just paddling into the current or milling offshore. Swimming birds that were also surface pecking were coded as foraging.

Each scan lasted 1-10 minutes depending on the number of birds, the

location of the flock, and the variety of behaviors. Disturbances by Bald Eagles (Haliaeetus leucocephalus), Ospreys (Pandion haliaetus), low flying planes, boats and other events were recorded during each 15 minute interval. I also inspected the eelgrass beds for evidence of oil.

Observations made at the beginning and end of a daily observation period were treated as half samples, and daily means for each behavior category were calculated by:

$$\text{Mean} = \left[\frac{O_1 + O_x}{2} + \sum_{i=2}^{x-1} O_i \right] (x-1)^{-1}$$

where O = observation period, and x = number of observation periods.

Tide levels were taken from Canadian Hydrographic Service Tide and Current Tables Vol. 6. All times are Pacific Daylight Savings Time. Weather conditions on each day of observation are recorded in Table 1.

Table 1. Weather conditions during the study of Brant behavior on Stubbs Island, April 1989.

Date	Cloud cover	Wind (mph)
17 April	clear	light southerlies
18 April	sunny, clouds to SE	south 10
22 April	cloudy, rain	southeast 5-10
25 April	clear	northeast 10
26 April	broken cloud	southeast 5-10
27 April	cloudy	calm
28 April	clear	calm

Detailed observations made during this study are appended. Behavioral observations are presented in Appendix I. The proportion of birds engaged in each behavior as a percent of the total birds present, and sources and frequency of disturbances are shown in Appendix II.

RESULTS

Arrival of Brant

The first Brant sighted on Stubbs Island during the study period were two birds present on 21 March. Fifty to 60 Brant stopped briefly on Stubbs Island around 28 March, and about 100 were present for a short period on 5 April (D. Banks pers. comm.). None were observed during surveys on 20 March, 21 March, 3 April and 4 April (see Rodway 1989). A maximum of 366 gathered around Stubbs during the afternoon of 17 April, and numbers peaked on 18 April at a total of 480 birds. Variable numbers were present between 18 April and 28 April, when all Brant left the area. None were seen on 29 or 30 April and no further observations were made.

Brant staged primarily in Heynen Channel and Father Charles Channel off the north and west sides of Clayoquot Spit (Fig. 1). Some flocks moved periodically into the north end of Van Nevel Channel on the east side of the spit. They came ashore only on the north end and in the north bay of Clayoquot Spit. The only exception to this occurred on 27 April when the flock on Clayoquot Spit was disturbed by a Bald Eagle and landed for a brief 20 minute period on the mudflats around Deadman Islets. I never saw birds land on the east side or on the northwest bay of Stubbs Island, though there are eelgrass beds in those locations. Birds foraged across the north bay when eelgrass flats were exposed, but at higher tide levels spent their time only on the western of the two sandspits which embrace the north bay.

Activity patterns

Over the entire study period, Brant spent more time swimming offshore than foraging (Tables 2 and 3). Overall means of the percentage of birds engaged in each behavior indicate that Brant spent 43 percent of their time swimming compared to 35 percent foraging (Table 2). The percent of time spent

foraging ranged from three percent on 28 April to 55 percent on 25 April. Weighting each sample according to the number of birds involved in each observation, showed that the actual time spent foraging by all birds was only 32 percent compared to 48 percent spent swimming offshore (Table 3).

Table 2. Mean numbers of birds and mean daily activity of migrating Brant at Stubbs Island, April 1989.

	Mean no. of birds	Foraging (%)	Swimming (%)	Flying (%)	Preening (%)	Other (%)
17 April	227	9	80	9	0	2
18 April	361	20	56	15	7	2
22 April	309	53	33	5	7	2
25 April	52	55	21	4	17	3
26 April	124	15	59	16	10	0
27 April	118	52	22	9	17	0
28 April	39	3	97	0	0	0
Overall		35	43	10	10	2

Table 3. Total Brant-hours spent in various activities by migrating Brant during observations at Stubbs Island, April 1989.

	Behavior (Brant-hours)					
Date	Foraging	Swimming	Flying	Preening	Other	Total
17 April	51	468	41	0	10	568
18 April	798	1995	500	259	57	3608
22 April	1163	842	100	157	57	2318
25 April	176	78	11	39	8	311
26 April	156	622	147	130	3	1058
27 April	462	180	78	153	2	874
28 April	0	14	0	0	0	15
Total	2806	4198	875	736	138	8753
Percent	32	48	10	8	2	100

The proportion of time spent foraging varied in relation to the level of the tide (Table 4, Fig. 2-5). Brant spent more time foraging at low and medium tides than at high tide. Near low tide, foraging was the predominant

behavior, but during medium and high tide, swimming was more frequent.

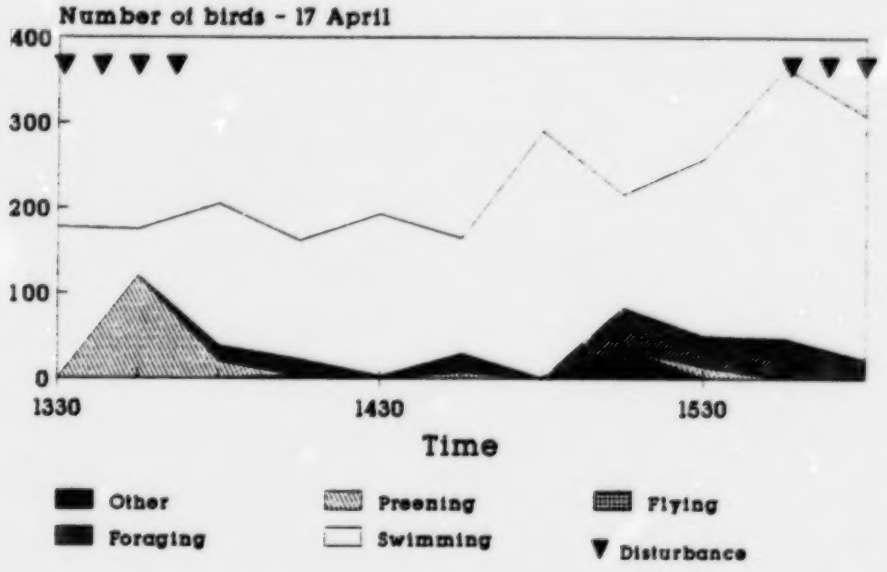
Table 4. Mean activity during three phases of the tide (see Appendix II) of migrating Brant at Stubbs Island, April 1989.

	Number of observation periods	Foraging (%)	Swimming (%)	Flying (%)	Preening (%)	Other (%)
Low tide	69	54	26	9	11	1
Medium tide	67	30	42	10	14	3
High tide	40	8	77	11	3	0

Most foraging occurred on shore or at shore. Of the total foraging behavior observed, 36 percent was coded as grazing, 31 percent as surface pecking atshore, and one percent as probing. Foraging offshore included eight percent surface pecking, seven percent "head dunking", and one percent "tipping-up". "Head-dunking" and "tipping -up" occurred when eelgrass beds were covered with shallow water, primarily during ebbing tides.

Flying comprised 10 percent of the total activity of Brant at Stubbs Island. It was often a result of disturbance (see below), but also occurred when flocks were moving from offshore onto drying mudflats and eelgrass beds, as well as when flocks were preparing to leave the area and continue their migration northward. It occurred in similar proportions at all tide levels (Table 4).

Birds engaged in preening activities 10 percent of the time (Table 2). Almost all preening occurred on shore or at shore. Birds were infrequently seen bathing offshore. Bathing at shore constituted a small proportion (not calculated) of total preening behavior, most of which consisted of birds standing on the sand and preening their feathers. Preening behavior was seen more often at medium and low tides than at high tides when birds spent most of their time offshore (Table 4).



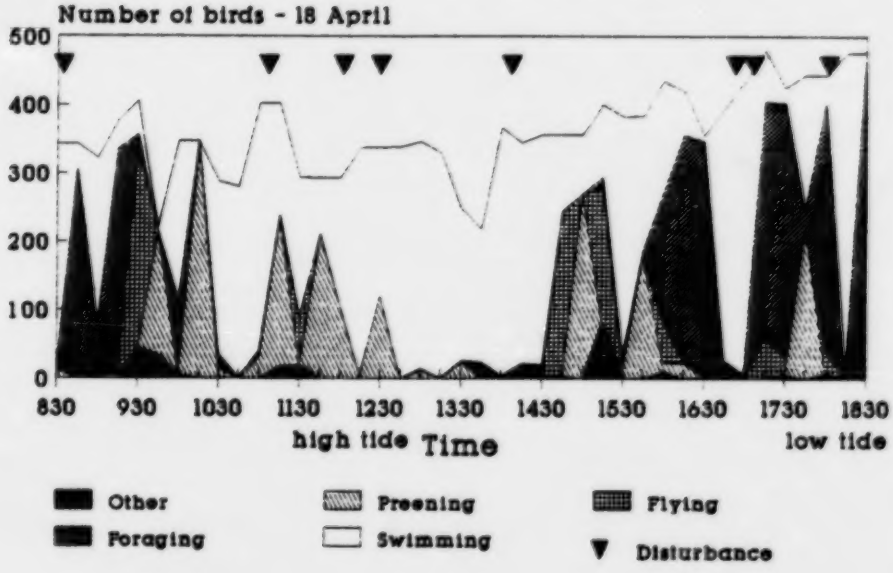


Figure 2. Brant activity at Stubbs Island on 17 and 18 April 1989.

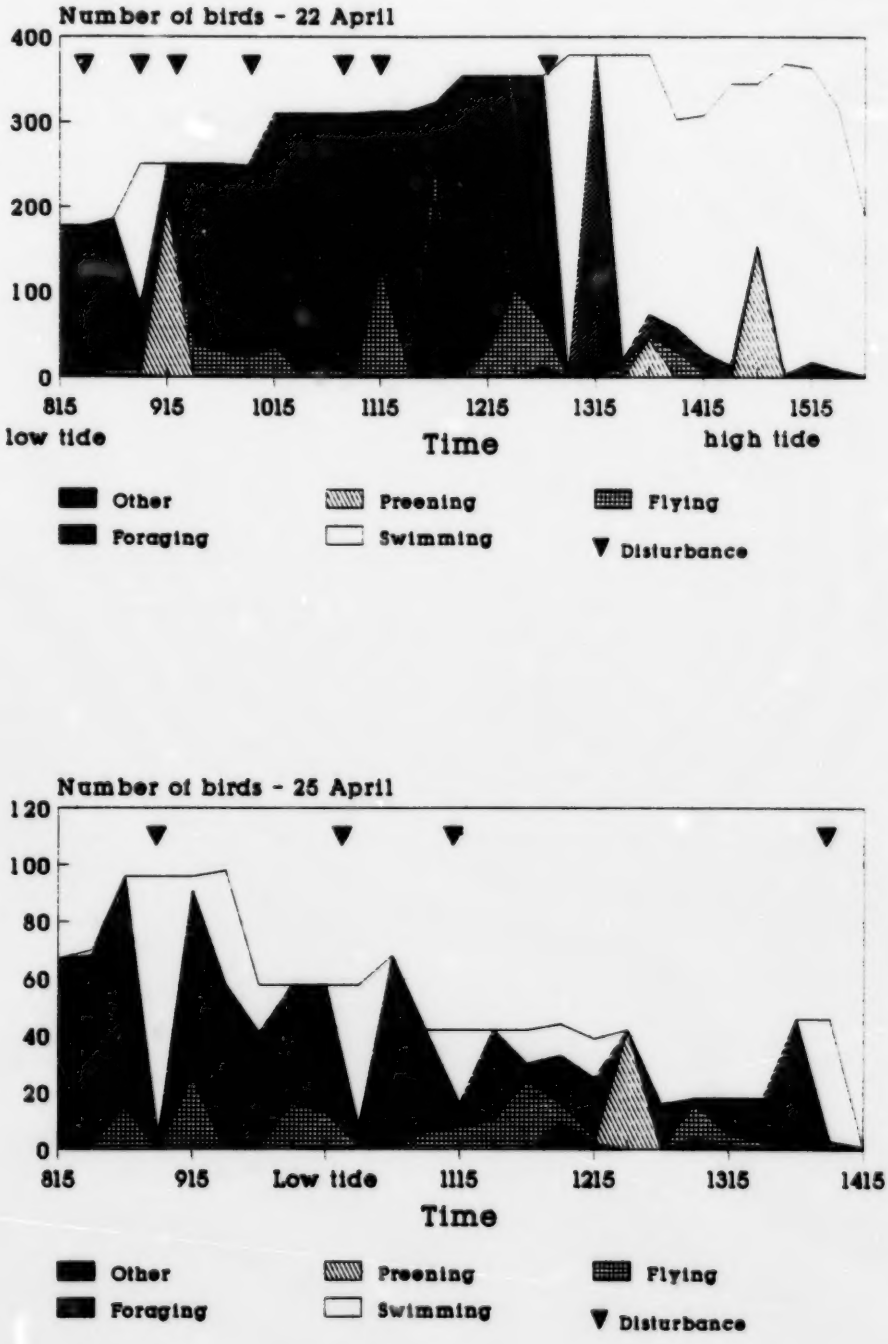


Figure 3. Brant activity at Stubbs Island on 22 and 25 April 1989.

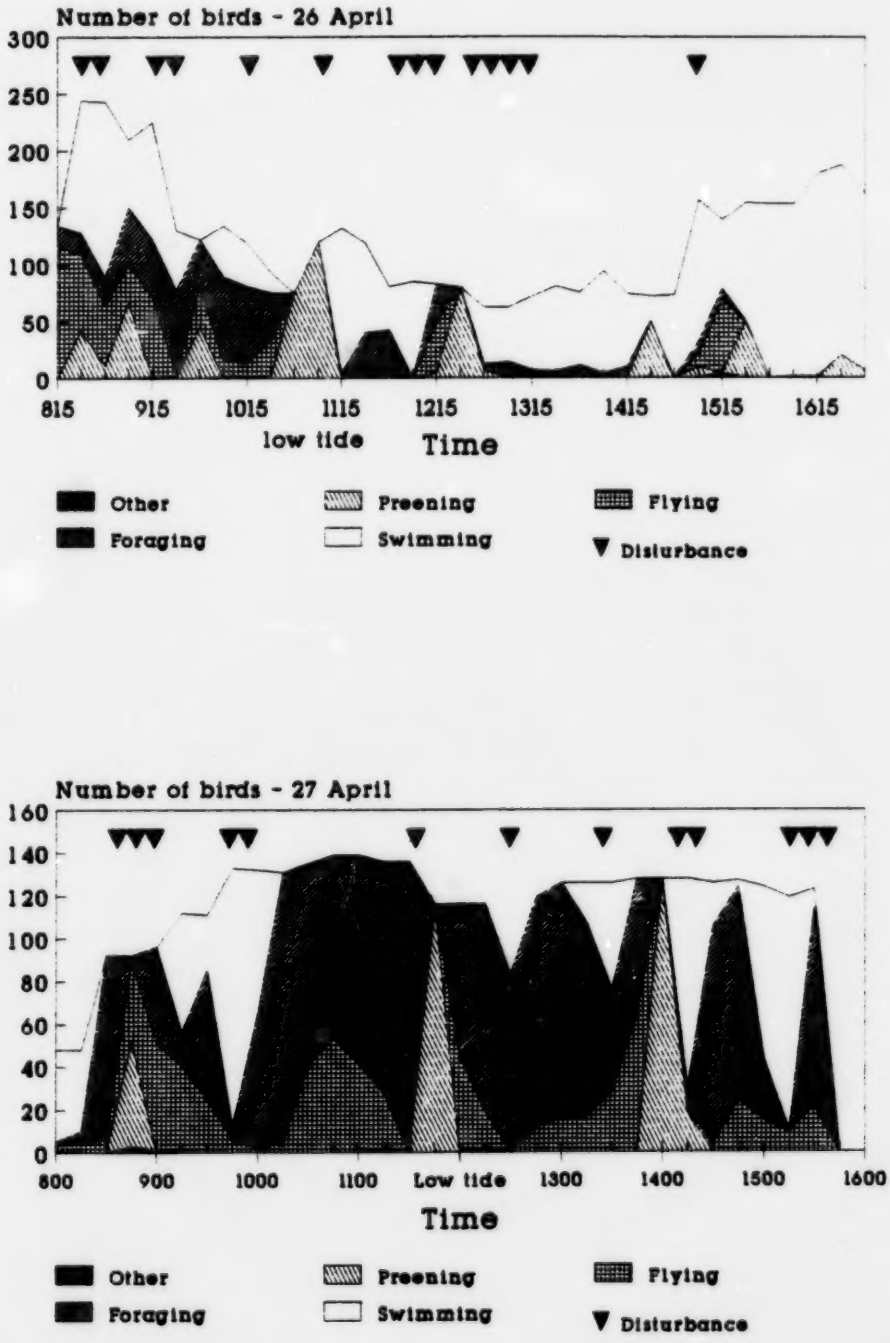


Figure 4. Brant activity at Stubbs Island on 26 and 27 April 1989.

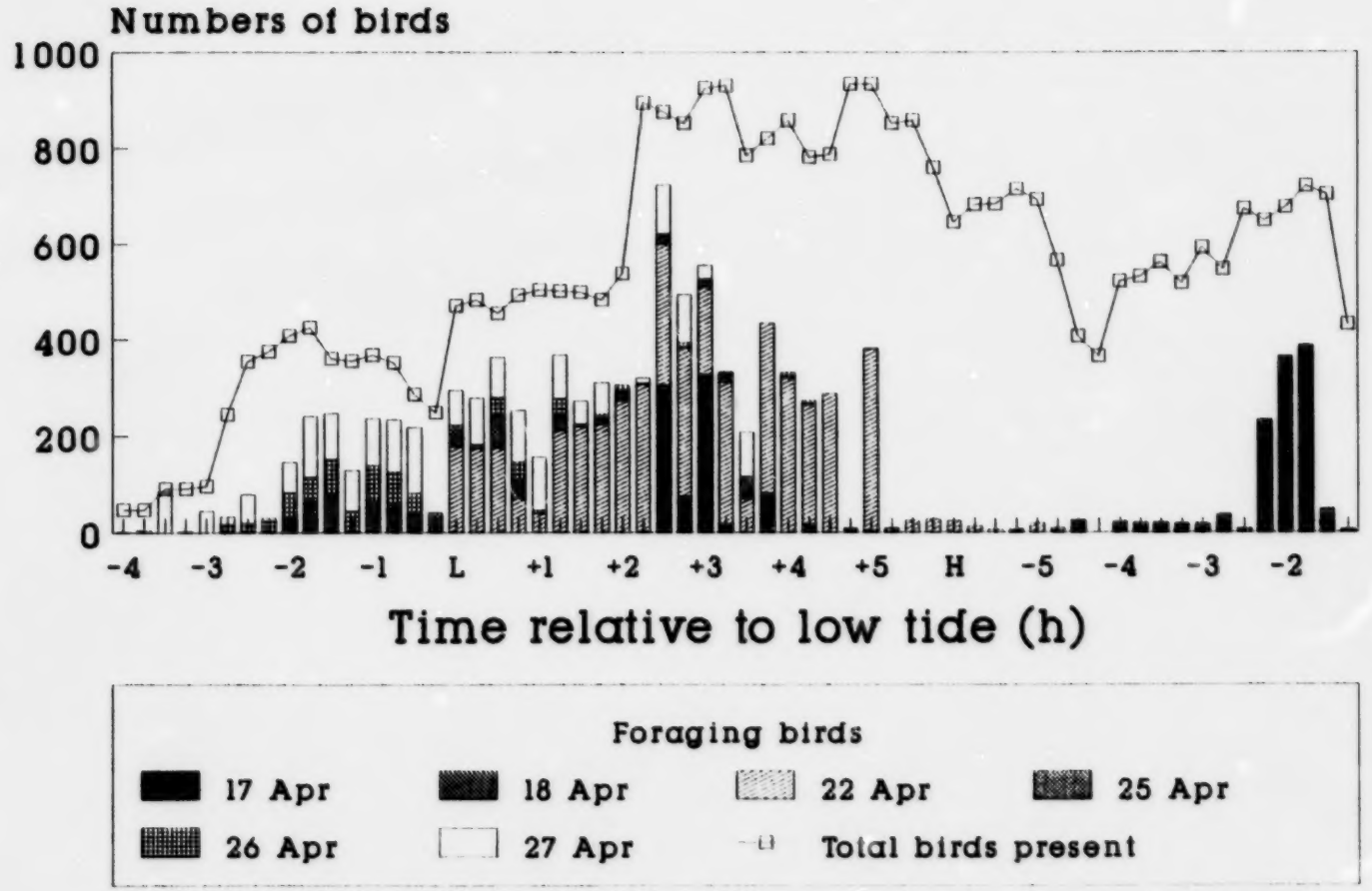


Figure 5. Brant foraging activity in relation to tide level at Stubs Island, April 1989.

Other activities constituted two percent of behaviors observed, most of which involved birds standing or walking along the sand. Over all observation periods, 28 birds were observed engaged in agonistic encounters, and only six were observed sleeping. Those behaviors occurred only on shore.

Disturbance

I recorded disturbances which set Brant flocks into the air during 54 (31%) of the 176 observation intervals (Fig. 2-4, Appendix II). The degree of disruption varied. On some occassions birds would fly up, circle briefly, and return to their former location within one or two minutes. Other times, if scared from feeding areas, they would circle and land offshore, then slowly paddle back, taking five to 15 minutes to return to shore. Those frequent disruptions of foraging activity likely reduced the amount of time Brant spent feeding.

Bald eagles were responsible for most disturbance, and along with Ospreys, caused 39 (64%) of the 61 instances observed. As well, other disturbances recorded with unknown causes (see Appendix II) may have been attributable to eagles or Ospreys that I could not see, either because I was involved in an observation, or because of limited visibility. Brant immediately took flight whenever a soaring eagle or Osprey approached Clayoquot Spit, even if the predator was flying at considerable altitude. Similar responses to eagles were reported by Kramer et al. (1979) at San Quentin Bay, Mexico, and by Jones and Jones (1966) at Izembek Lagoon, Alaska.

Boats and aircraft passing close by created 25 percent of disturbances. Float planes taking off and landing in Tofino harbour frequntly flew low over Clayoquot Spit, flushing feeding or staging birds into the air. Brant generally did not react to planes flying at altitudes above 150 m. Boats mainly disturbed birds swimming offshore, and, unless running along the shore

of the island, were not a concern for feeding birds.

Brant displayed mixed reactions to the presence of mammalian predators. As many as four raccoons (Procyon lotor) were regularly observed hunting crabs on the eelgrass flats, causing no alarm to Brant grazing close by. Yet on one occassion, a river otter (Lutra canadensis) walked across the same eelgrass bed, and all Brant took flight ahead of it.

Presence and affect of oil

Small pockets of eelgrass in the northwest bay of Stubbs Island were still coated with oil, but Brant did not forage there (Fig. 1). There was no indication during this study or from anecdotal reports by local observers that Brant normally used that area. No oil was detected in the main foraging area on the north end of the island.

Herring (Clupea harengus), which traditionally spawn in the vicinity of Stubbs Island, did not spawn there in 1989 (D. Chalmers pers. comm.). Herring spawn may be an important food resource for migrating Brant in some areas (A. Reed pers. comm.), but there have been no previous studies of Brant foraging at Stubbs Island, and it is not known to what extent they normally feed on herring spawn there. Herring may have been displaced by the presence of oil in the area, but the impact of oil on the distribution of herring spawn was beyond the scope of this study.

Observations of marked birds

All Brant observed on Stubbs Island were checked for leg bands and nasal disks. No birds with leg bands were present during the study, but at least three different birds with nasal disks were sighted. One bird with a round, white nasal disk was present on 18 , 22 and 26 April in flocks of 294, 251 and 122 birds respectively. It may have been the same bird on all three days. On

27 April, there was one bird with a square, white disk, and another with a square, orange disk in a flock of 126 birds. Those birds were marked in the Teshekpuk Lake area of northern Alaska (see Dawe and Nygren 1989).

DISCUSSION

During the past 100 years, there has been a drastic decline of Brant wintering in British Columbia, and they now occur primarily as spring migrants (Campbell et al. 1989). The majority of Brant on the Pacific coast now winter south of British Columbia. Hunting, human encroachment and disturbance are thought to be responsible for this shift in winter distribution. In the early 1970's, Hatler et al. (1978) recorded as many as 4,000 Brant at Stubbs Island during spring migration, but in 1989, a maximum of 480 birds were counted, suggesting a decline in numbers visiting the island.

Feeding was frequently disrupted by disturbance during this study, and the amount of time Brant spent foraging was likely reduced. The percentage of time spent foraging on Stubbs Island (32%) was lower than that reported elsewhere. In late August and early September, migrating Brant on the north slope of Alaska fed during 77% of daylight hours (Kiera 1984), and undisturbed Brant at San Quentin Bay, Mexico foraged during 78 percent of daylight hours (Kramer et al. 1979). In the Danish Wadden Sea in autumn, Brant fed almost continuously from 3-4 hours before to 3-4 hours after low tide (Madsen 1988). Owens (1977) found that the percentage of time spent feeding by Brant wintering in Essex varied between 42 and 82%, and that disturbance reduced the amount of time spent foraging by as much as 11.5%.

Though Ranwell and Downing (1959) state that Brant are primarily diurnal feeders, observations by Owens (1977) and Madsen (1988) reveal that birds will feed intensively at night. Owens suggests that they may feed more at night to

compensate for disturbance during the day. No nocturnal observations were made during this study to determine if this may have occurred at Stubbs Island.

Stubbs Island is the main stopover site for migrating Brant along the west coast of Vancouver Island, and annual monitoring at that site is warranted to determine population trends. Studies of foraging patterns in areas with less disturbance would help interpret behavior patterns on Stubbs Island, and determine if disturbance levels are discouraging use of the area by Brant.

The oiling that occurred on Stubbs Island from the Nestucca spill did not appear to affect foraging behavior of migrating Brant. Birds did not use oiled areas on the west side of Clayoquot Spit, but there was no indication in the behavior observed in 1989, or from anecdotal accounts by local observers, that that area was traditionally used for foraging or staging. Whether oiling affected the distribution of herring spawn, and indirectly affected the fitness of Brant by decreasing the quality of available food, can only be speculated on. Brant take more animal food as they move northward during migration, and are known to feed selectively on herring spawn (Cottam et al. 1944). We need to know what other staging areas are used by populations that visit Stubbs Island, and the relative importance of Stubbs Island as a feeding area, before we can evaluate the overall affects of changes in the nutritional quality of available food at that site.

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Appendix L. Activity of migrating Brant at Stubbs Island, April 1989.

Time (hrs.)	Total birds	Number of birds: Tipping up	Head dunking	Surface pecking (offshore)	Surface pecking (atshore)	Grazing	Probing	Total foraging	Swimming	Preening	Flying	Walking/ Standing/ Sleeping/ Agonistic
17 April (low tide @ 1735 h)												
1330	178							0	178	0	0	
1345	175							0	55	0	120	
1400	205			18				18	167	0	20	
1415	162			6	12			18	140	0	0	4
1430	193			3				3	190	0	0	
1445	165			21				21	136	0	8	
1500	290							0	290	0	0	
1515	216		26	22				48	133	0	0	35
1530	258			36				36	208	0	14	
1545	366			47				47	319	0	0	
1600	309			22				22	287	0	0	
18 April (low tide @ 1810 h)												
830	343			3				3	328	0	12	
845	343				301	5		306	37	0	0	
900	322				76			76	242	4	0	
915	377	7	8		75	33		329	42	6	0	
930	406			1	16			17	50	295	0	44
945	221							0	6	0	180	35
1000	347			8	74			82	232	26	1	6
1015	347							0	0	0	347	
1030	288			17				17	252	5	14	
1045	280							0	280	0	0	
1100	402			9				9	361	0	32	
1115	402			4				4	163	0	218	17
1130	293			1				1	203	71	0	19
1145	293							0	82	0	211	
1200	293							0	187	0	106	
1215	338							0	333	1	4	
1230	338							0	218	0	120	
1245	339							0	339	0	0	
1300	346			2				2	332	0	12	
1315	330							0	330	0	0	
1330	249			2				2	223	0	24	
1345	219			23				23	195	1	0	
1400	367							0	363	0	4	
1415	345	3		19				22	323	0	0	
1430	357			19				19	337	0	0	1
1445	358			1				1	112	242	0	2
1500	357							0	87	0	270	
1515	401				15			15	107	198	0	81
1530	383	1		16				17	349	4	13	
1545	384			7				7	198	0	179	
1600	434	6	5	7	169			187	163	60	14	10

cont'd

Appendix I. (cont'd)

Time (hrs.)	Total birds	Number of birds: Tipping up	Head dunking	Surface pecking (offshore)	Surface pecking (atshore)	Grazing	Probing	Total foraging	Swimming	Preening	Flying	Walking/ Standing/ Sleeping/ Agonistic
1615	420		300	1	30			331	64	2	23	
1630	356		x		x	6		342	10	2	0	2
1645	395	8	6		13			27	368	0	0	
1700	434			6				6	428	0	0	
1715	480		x	3	x	x		347	75	58	0	
1730	426					371		371	24	26	0	5
1745	444	5	24					29	195	0	220	
1800	444					361		361	42	34	0	7
1815	476			8				8	468	0	0	
1830	476				470			470	6	0	0	
22 April (low tide @ 0820 h)												
815	178					178		178	0	0	0	
830	178					175		175	0	3	0	
845	186					176		176	0	10	0	
900	251			41	30			71	167	11	0	2
915	251				39			39	0	7	205	
930	251					212		212	0	39	0	
945	251					220		220	0	31	0	
1000	249					225		225	0	24	0	
1015	310					273		273	0	37	0	
1030	310				2	303		305	0	5	0	
1045	310		x		x	150		295	0	15	0	
1100	310		x		x			308	0	2	0	
1115	313				182			182	0	131	0	
1130	313				296			296	0	17	0	
1145	323				70			70	0	44	0	209
1200	354	1	2		350			353	0	1	0	
1215	354				240	81		321	0	29	0	4
1230	354				170	78		248	0	106	0	
1245	354			99	40	149		288	0	53	0	13
1300	379							0	379	0	0	
1315	379			113	50	214		377	0	2	0	
1330	379			4	2			6	359	14	0	
1345	379			22		3		25	305	4	45	
1400	303			27				27	245	31	0	
1415	308			21		2		23	278	6	0	1
1430	345			12				12	331	2	0	
1445	345			5				5	190	0	150	
1500	369			4				4	365	0	0	
1515	364			18				18	346	0	0	
1530	317			7				7	308	2	0	
1545	189			2				2	187	0	0	

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Appendix I. (cont'd)

Time (hrs.)	Total birds	Number of birds: Tipping up	Head dunking	Surface pecking (offshore)	Surface pecking (atshore)	Grazing	Probing	Total foraging	Swimming	Preening	Flying	Walking/ Standing/ Sleeping/ Agonistic
25 April (low tide @ 1015 h)												
815	67	30				3		33	0	4	0	30
830	70	1	x		x	8		66	2	2	0	
845	96	3			14	64		81	0	15	0	
900	96			4				4	92	0	0	
915	96				66			66	5	25	0	
930	98			58				58	40	0	0	
945	58				38	2		40	17	1	0	
1000	58				42			42	0	16	0	
1015	58				45			45	0	12	0	1
1030	58					7		7	50	1	0	
1045	68				67			67	0	1	0	
1100	42					36		36	0	6	0	
1115	42				8			8	26	8	0	
1130	42				32			32	0	10	0	
1145	42				6			6	12	24	0	
1200	44				17			17	11	7	0	9
1215	39				20			20	14	3	0	2
1230	42							0	0	0	42	
1245	16					16		16	0	0	0	
1300	18					2		2	0	12	0	4
1315	18					13		13	0	5	0	
1330	18					15		15	0	2	0	1
1345	46		46					46	0	0	0	
1400	46							0	43	2	0	1
1415	1							0	0	1	0	
26 April (low tide @ 1100 h)												
815	134				5	12		17	0	117	0	
830	244			4	4	11		19	116	67	42	
845	243			7		18		25	154	53	11	
900	210				11	39		50	60	33	67	
915	225					50		50	103	71	0	1
930	130		x		x	31		72	53	5	0	
945	122						41	41	0	36	45	
1000	134			1	72			73	45	15	0	1
1015	119		49	6			13	68	38	13	0	
1030	93		6				36	42	18	33	0	
1045	75							0	0	0	75	
1100	120							0	0	0	120	
1115	132			1				1	128	3	0	
1130	119			8	28		2	38	79	2	0	
1145	81		x		x	29		40	39	2	0	
1200	85							0	85	0	0	
1215	83		x		x	12		34	0	44	5	
1230	80							0	0	0	80	

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Appendix I. (cont'd)

Time (hrs.)	Total birds	Number of birds: Tipping up	Head dunking	Surface pecking (offshore)	Surface pecking (atshore)	Grazing	Probing	Total foraging	Swimming	Preening	Flying	Walking/ Standing/ Sleeping/ Agonistic
1245	62			5				5	50	0	7	
1300	62	2	1	11				14	48	0	0	
1315	72					2		2	65	0	0	5
1330	81			1		4		5	75	0	0	1
1345	75			5		3		8	64	3	0	
1400	94			3				3	90	0	1	
1415	74			4				4	64	6	0	
1430	72							0	22	0	50	
1445	73							0	73	0	0	
1500	156			11				11	125	10	10	
1515	139			1		8		9	61	65	0	4
1530	154							0	104	0	50	
1545	153							0	153	0	0	
1600	153			1				1	152	0	0	
1615	180			1				1	179	0	0	
1630	187							0	167	0	20	
1645	163							0	156	0	7	
27 April (low tide @ 1155 h)												
800	48					1		1	43	2	0	2
815	48			5				5	38	5	0	
830	92				86			86	0	6	0	
845	92				3			3	0	37	49	3
900	96	35			10			45	0	50	0	1
915	112	2	1		3	10		16	56	40	0	
930	111			7	53			60	26	25	0	
945	133			6				6	121	6	0	
1000	132			63				63	67	2	0	
1015	131		72			54		126	0	5	0	
1030	135		56		39			95	0	40	0	
1045	139		70				15	85	0	54	0	
1100	139		50				48	98	0	41	0	
1115	136					108		108	0	27	0	1
1130	136	(on flats N of Tofino)				136		136	0	0	0	
1145	116							0	0	0	116	
1200	116					72		72	0	44	0	
1215	116					97		97	0	17	0	2
1230	83		72		11			83	0	0	0	
1245	119		x		x	45		107	0	12	0	
1300	126					110		110	0	16	0	
1315	126	2	x		x	12		91	19	16	0	
1330	126			25	23			48	50	28	0	
1345	128				64			64	0	64	0	
1400	128							0	0	0	128	
1415	128			11				11	98	1	18	
1430	126	2	x		22	x		102	20	4	0	

cont'd

Appendix L. (cont'd)

Time (hrs.)	Total birds	Number of birds: Tipping up	Head dunking	Surface pecking (offshore)	Surface pecking (atshore)	Grazing	Probing	Total foraging	Swimming	Preening	Flying	Walking/ Standing/ Sleeping/ Agonistic
1445	127				100			100	3	24	0	
1500	124				28			28	81	15	0	
1515	119			1				1	109	9	0	
1530	123	12	70	1	10			93	9	21	0	
1545	0							0	0	0	0	
1600	0							0	0	0	0	
28 April (low tide @ 1300 h)												
845	39			2				2	37	0	0	
900	39							0	39	0	0	
915	0							0	0	0	0	
930	0							0	0	0	0	
945	0							0	0	0	0	

Appendix II. Summary of Brant activity, disturbance and the phase of the tide on Stubbs Island, April 1989. The tidal cycle is broken into three phases: 1 - 2 h before to 2 h after low tide; 2 - 2 to 4 h before and after low tide; and 3 - 4 h after to 4 h before low tide. "Other" activities include walking, standing, sleeping and agonistic. BAEA = Bald Eagle; OSPR = Osprey.

Time (h)	Tide phase	Total birds	Foraging (%)	Swimming (%)	Flying (%)	Preening (%)	Other (%)	Disturbance during interval BAEA	OSPR	Plane	Boat	Unknown
17 Apr												
1330	3	178	0	100	0	0	0					x
1345	2	175	0	31	69	0	0					x
1400	2	205	9	81	10	0	0					x
1415	2	162	11	86	0	0	2					x
1430	2	193	2	98	0	0	0					
1445	2	165	13	82	5	0	0					
1500	2	290	0	100	0	0	0					
1515	2	216	22	62	0	0	16					
1530	2	258	14	81	5	0	0		x			
1545	1	366	13	87	0	0	0	x				
1600	1	309	7	93	0	0	0	x				
(Low tide @ 1735 h)												
18 Apr												
830	2	343	1	96	3	0	0	x				
845	2	343	89	11	0	0	0					
900	2	322	24	75	0	1	0					
915	2	377	87	11	0	2	0					
930	2	406	4	12	0	73	11					
945	2	221	0	3	81	0	16					
1000	2	347	24	67	0	7	2					
1015	3	347	0	0	100	0	0					
1030	3	288	6	88	5	2	0					
1045	3	280	0	100	0	0	0					
1100	3	402	2	90	8	0	0		x			
1115	3	402	1	41	54	0	4					
1130	3	293	0	69	0	24	6					
1145	3	293	0	28	72	0	0					
1200	3	293	0	64	36	0	0	x			x	
High tide		338	0	99	1	0	0					
1230	3	338	0	64	36	0	0	x				
1245	3	339	0	100	0	0	0					
1300	3	346	1	96	3	0	0					
1315	3	330	0	100	0	0	0					
1330	3	249	1	90	10	0	0					
1345	3	219	11	89	0	0	0					
1400	3	367	0	99	1	0	0		x			
1415	2	345	6	94	0	0	0					
1430	2	357	5	94	0	0	0					
1445	2	358	0	31	0	68	1					
1500	2	357	0	24	76	0	0					
1515	2	401	4	27	0	49	20					

cont'd

Appendix II. (cont')

Time (h)	Tide phase	Total birds	Foraging (%)	Swimming (%)	Flying (%)	Preening (%)	Other (%)	Disturbance during interval BAEA	OSPR	Plane	Boat	Unknown
1530	2	383	4	91	3	1	0					
1545	2	384	2	52	47	0	0					
1600	2	434	43	38	3	14	2					
1615	1	420	79	15	5	0	0					
1630	1	356	96	3	0	1	1					
1645	1	395	7	93	0	0	0					Gull cries
1700	1	434	1	99	0	0	0	x				
1715	1	480	72	16	0	12	0					
1730	1	426	87	6	0	6	1					
1745	1	444	7	44	50	0	0					Flying Brant
1800	1	444	81	9	0	8	2					
Low tide		476	2	98	0	0	0					
1830	1	476	99	1	0	0	0					
22 Apr												
Low tide		178	100	0	0	0	0					
830	1	178	98	0	0	2	0	x				
845	1	186	95	0	0	5	0					
900	1	251	28	67	0	4	1	x				
915	1	251	16	0	82	3	0	x				
930	1	251	84	0	0	16	0					
945	1	251	88	0	0	12	0					
1000	1	249	90	0	0	10	0					x
1015	1	310	88	0	0	12	0					
1030	2	310	98	0	0	2	0					
1045	2	310	95	0	0	5	0					
1100	2	310	99	0	0	1	0	x				
1115	2	313	58	0	0	42	0	x				
1130	2	313	95	0	0	5	0					
1145	2	323	22	0	0	14	65					
1200	2	354	100	0	0	0	0					
1215	2	354	91	0	0	8	1					
1230	3	354	70	0	0	30	0					
1245	3	354	81	0	0	15	4			x		
1300	3	379	0	100	0	0	0					
1315	3	379	99	0	0	1	0					
1330	3	379	2	95	0	4	0					
1345	3	379	7	80	12	1	0					
1400	3	303	9	81	0	10	0					
1415	3	308	7	90	0	2	0					
1430	3	345	3	96	0	1	0					
High tide		345	1	55	43	0	0					
1500	3	369	1	99	0	0	0					
1515	3	364	5	95	0	0	0					
1530	3	317	2	97	0	1	0					
1545	3	189	1	99	0	0	0					

cont'd

Appendix II. (cont')

Time (h)	Tide phase	Total birds	Foraging (%)	Swimming (%)	Flying (%)	Preening (%)	Other (%)	Disturbance during interval BAEA	OSPR	Plane	Boat	Unknown
25 Apr												
815	2	67	49	0	0	6	45					
830	1	70	94	3	0	3	0					
845	1	96	84	0	0	16	0					
900	1	96	4	96	0	0	0	x				
915	1	96	69	5	0	26	0					
930	1	98	59	41	0	0	0					
945	1	58	69	29	0	2	0					
1000	1	58	72	0	0	28	0					
Low tide		58	78	0	0	21	2	x				
1030	1	58	12	86	0	2	0					
1045	1	68	99	0	0	1	0					
1100	1	42	86	0	0	14	0	x				
1115	1	42	19	62	0	19	0					
1130	1	42	76	0	0	24	0					
1145	1	42	14	29	0	57	0					
1200	1	44	39	25	0	16	20					
1215	1	39	51	36	0	8	5					
1230	2	42	0	0	100	0	0					
1245	2	16	100	0	0	0	0					
1300	2	18	11	0	0	67	22					
1315	2	18	72	0	0	28	0					
1330	2	18	83	0	0	11	6					
1345	2	46	100	0	0	0	0					
1400	2	46	0	93	0	4	2					River otter
1415	2	1	0	0	0	100	0					
26 Apr												
815	2	134	13	0	0	87	0					
830	2	244	8	48	17	27	0	x				
845	2	243	10	63	5	22	0	x				
900	2	210	24	29	32	16	0					
915	1	225	22	46	0	32	0			x		
930	1	130	55	41	0	4	0	xx				
945	1	122	34	0	37	30	0					
1000	1	134	54	34	0	11	1					
1015	1	119	57	32	0	11	0	x				
1030	1	93	45	19	0	35	0					
1045	1	75	0	0	100	0	0					
Low tide		120	0	0	100	0	0			x		
1115	1	132	1	97	0	2	0					
1130	1	119	32	66	0	2	0					
1145	1	81	49	48	0	2	0	x				
1200	1	85	0	100	0	0	0	xxx				
1215	1	83	41	0	6	53	0	x				
1230	1	80	0	0	100	0	0					x
1245	1	62	8	81	11	0	0	x		x		
1300	1	62	23	77	0	0	0	x				

cont'd

Appendix II. (cont')

Time (h)	Tide phase	Total birds	Foraging (%)	Swimming (%)	Flying (%)	Preening (%)	Other (%)	Disturbance during interval BAEA	OSPR	Plane	Boat	Unknown
1315	2	72	3	90	0	0	7	x				
1330	2	81	6	93	0	0	1					
1345	2	75	11	85	0	4	0					
1400	2	94	3	96	1	0	0					
1415	2	74	5	86	0	8	0					
1430	2	72	0	31	69	0	0					
1445	2	73	0	100	0	0	0					
1500	2	156	7	80	6	6	0	x				
1515	3	139	6	44	0	47	3					
1530	3	154	0	68	32	0	0					
1545	3	153	0	100	0	0	0					
1600	3	153	1	99	0	0	0					
1615	3	180	1	99	0	0	0					
1630	3	187	0	89	11	0	0					
1645	3	163	0	96	4	0	0					
27 Apr												
800	2	48	2	90	0	4	4					
815	2	48	10	79	0	10	0					
830	2	92	93	0	0	7	0	x				
845	2	92	3	0	53	40	3	x				
900	2	96	47	0	0	52	1				x	
915	2	112	14	50	0	36	0					
930	2	111	54	23	0	23	0					
945	2	133	5	91	0	5	0			x		
1000	1	132	48	51	0	2	0			x		
1015	1	131	96	0	0	4	0					
1030	1	135	70	0	0	30	0					
1045	1	139	61	0	0	39	0					
1100	1	139	71	0	0	29	0					
1115	1	136	79	0	0	20	1					
1130	1	136	100	0	0	0	0	x				
1145	1	116	0	0	100	0	0					
Low tide		116	62	0	0	38	0					
1215	1	116	84	0	0	15	2					
1230	1	83	100	0	0	0	0			x		x
1245	1	119	90	0	0	10	0					
1300	1	126	87	0	0	13	0					
1315	1	126	72	15	0	13	0	x				
1330	1	126	38	40	0	22	0					
1345	1	128	50	0	0	50	0					
1400	2	128	0	0	100	0	0			x		
1415	2	128	9	77	14	1	0					x
1430	2	126	81	16	0	3	0					
1445	2	127	79	2	0	19	0					
1500	2	124	23	65	0	12	0					
1515	2	119	1	92	0	8	0	xx				

cont'd

Appendix II. (cont')

Time (h)	Tide phase	Total birds	Foraging (%)	Swimming (%)	Flying (%)	Preening (%)	Other (%)	Disturbance during interval BAEA	OSPR	Plane	Boat	Unknown
1530	2	123	76	7	0	17	0				x	
1545	0	0	0	0	0	0	0	x				
1600	0	0	0	0	0	0	0					
28 Apr												
845	3	39	5	95	0	0	0					
900	3	39	0	100	0	0	0					
915	0	0	0	0	0	0	0			x		
930	0	0	0	0	0	0	0					
945	0	0	0	0	0	0	0					
(Low tide @ 1300 h)												